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[Title of the Invention]

EXTERNAL ELECTRODE TYPE FLUORESCENT TUBE

[Abstract] (amended)

[Problem]

To provide an external electrode type fluorescent tube having a structure in which stable visible and/or ultraviolet light can be obtained.

[Construction]

A linear or strip-shaped, first electrode 6 is provided to extend along a bulb-axis direction of an external surface of a bulb 1 and this electrode is covered with an insulator 8, and a second strip-shaped electrode 7 wider than this insulator is provided on the insulator so as to extend along a longitudinal direction of the bulb, these electrodes and insulator being provided approximately symmetrically with respect to the bulb-axis direction.

[Claims]

[Claim 1]

An external electrode type fluorescent discharge tube in which an inside of a tubular bulb is hermetically filled with at least one kind of rare gas such as Ne, Ne, Ar, Xe and Kr by a predetermined amount and an inside surface of the bulb is coated with a fluorescent material, characterized in that a linear or strip-shaped, first electrode is provided to extend along a bulb-axis direction of an external surface of the bulb and this electrode is covered with an insulator, and a second strip-shaped electrode wider than this insulator is provided on the insulator so as to extend along a longitudinal direction of the bulb, these electrodes and insulator being provided approximately symmetrically with respect to the bulb-axis direction.

[Claim 2]

An external electrode type fluorescent discharge tube according to claim 1, characterized in that a high frequency voltage to be applied to the electrodes is supplied from a power source including a step-up transformer and a high frequency oscillator made of a transistor, a field effect transistor or the like.

[Claim 3]

An external electrode type fluorescent discharge tube according to claim 2, characterized in that a thickness and

a material of the insulator are adjusted so that discharge during lighting is stabilized.

[Claim 4]

An external electrode type fluorescent discharge tube according to claim 2, characterized in that in the case where discharge is not stabilized by a dielectric constant and a resistance value of the insulator, electrical circuit devices such as a capacitor and a resistor are provided on an output side of the power source so as to light the fluorescent discharge tube.

[Claim 5]

An external electrode type fluorescent discharge tube according to claim 4, characterized in that mercury vapor is sealed in the inside of the bulb.

[Claim 6]

An external electrode type fluorescent discharge tube according to claims 1 to 5, characterized in that the fluorescent material on the inside surface of the bulb positioned between edges of the second strip-shaped electrode is removed and an aperture is provided.

[Claim 7]

An external electrode type fluorescent discharge tube according to claims 1 to 6, characterized in that the first electrode is a high voltage side, while the second strip-shaped electrode is a ground voltage side.

[Detailed Description of the Invention]

[0001]

[Industrial Field]

This invention relates to an external electrode type fluorescent discharge tube (hereinafter referred to as a fluorescent lamp or simply a lamp) for use in document illumination used in information equipment such as facsimile machines, copying machines and image readers, and for use in backlight units for liquid crystal display panels and the like.

[0002]

[Prior Art]

Fluorescent lamps of the type in which discharge is maintained by a pair of external electrodes formed on an outside wall of a bulb are used in light sources for OA equipment, backlights for display devices and the like. Referring to the drawings, Fig. 1 is an explanatory view of a lamp and a power source, and Fig. 2 is an explanatory view of a A-A cross section of the lamp. A pair of external electrodes 2 and 3 are provided on an external surface of a bulb 1 hermetically closed at both ends 100 and 101 in such a manner as to be spaced apart from each other in the circumferential direction. These external electrodes 2 and 3 are connected to a high frequency power source 4. Each of these external electrodes 2 and 3 is formed of metal tape such as aluminum tape or copper tape or an electrically conductive coating such as silver paste, so as

to extend in a strip-like shape along the axial direction of the bulb. An inside surface of the bulb 1 is coated with a fluorescent material 5. The bulb may be filled with only a rare gas such as xenon, or may also be filled with a predetermined amount of mercury and a rare gas.

[0003]

In such a lamp, when a high frequency current flows between the external electrodes 2 and 3 from the high frequency power source 4, discharge 10 is performed in the bulb 1 and a rare gas or mercury is ionized and excited to emit ultraviolet rays, and these ultraviolet rays are converted to visible light by the fluorescent material 5 and emitted to the outside.

[0004]

[Problems that the Invention is to Solve]

However, there is a case where the high frequency current between the external electrodes 2 and 3 is affected by the nonuniformity of the contact between glass and the external electrodes, the nonuniformity of glass wall thickness, small variations in the high frequency current, and the like, so that the discharge 10 appears in a striped pattern along the effective emission surface 9 and is brought into an unstable state. Particularly as the high frequency current becomes smaller, this phenomenon appears more remarkably. This unstable discharge 10 also affects visible light emitted from the fluorescent material 5, and similarly, visible light

emitted from the effective emission surface 9 assumes a striped pattern and becomes unstable.

[0005]

If the fluorescent lamp is used for document illumination in information equipment such as facsimile machines, copying machines and image readers, such phenomenon causes the problem that information cannot be accurately transmitted, while if the fluorescent lamp is used in a backlight unit for liquid crystal display panels, the phenomenon causes problems such as flickers or jitters.

[0006]

The invention has been made in view of the above-mentioned problems, and an object of the invention is to provide an external electrode type fluorescent discharge tube having an external electrode type structure in which stable visible and/or ultraviolet light can be obtained.

[0007]

[Means for Solving the Problem]

An object of the invention is achieved by providing an external electrode type fluorescent discharge tube in which a linear or strip-shaped, first electrode is provided to extend along a bulb-axis direction of an external surface of a bulb and this electrode is covered with an insulator, and a second strip-shaped electrode wider than this insulator is provided on the insulator so as to extend along a longitudinal direction

of the bulb, these electrodes and insulator being provided approximately symmetrically with respect to the bulb-axis direction.

[0008]

[Function]

According to the invention, because a discharge path in which a high frequency current flows is invisible from an effective emission surface, visible light can be stably emitted from a lamp, and far more stable visible light can be obtained by adjusting the electrical characteristics of the insulator.

[0009]

[Embodiment]

One embodiment of the invention will be described below with reference to the accompanying drawings. Fig. 3 is an explanatory view of a lamp and a power source according to the invention, and Fig. 4 is an explanatory view of an A-A cross section of the lamp according to the invention. In Figs. 3 and 4, reference numeral 1 denotes a bulb closed at opposite ends 100 and 101. The inside surface of the bulb 1 is coated with a fluorescent material 5, and the fluorescent material on the inside surface of the bulb between edges 102 and 103 of a second strip-shaped electrode 7 is removed and an aperture 13 is provided in place of the removed fluorescent material. A first electrode 6 is a strip-shaped electrode which is provided to extend along the bulb-axis direction of the bulb

1, and is formed of metal tape such as aluminum tape or copper tape or an electrically conductive coating such as silver paste. Reference numeral 8 denotes an insulator which is provided to cover the first electrode 6. The second electrode 7 is a strip-shaped electrode wider than the insulator 8, and is provided to extend along the bulb-axis direction of the bulb 1 so as to cover the insulator 8. The edges 102 and 103 of the second electrode 7 are preferably disposed to extend along edges 104 of the opening angle of the aperture 13 determined by the removal of the fluorescent material. In addition, the electrode 6, the insulator 8 and the electrode 7 are provided in such a manner that their respective central sections are approximately superposed on one another along the bulb-axis direction, and an effective emission surface 9 is disposed in the forward direction of the electrode 6. The electrode 6 and the electrode 7 are connected to a high frequency power source 4.

[0010]

In the case of this arrangement, when a high frequency current flows from the high frequency power source 4 to the first electrode 6 and the second electrode 7, for example, a high frequency current which flows from the electrode 6 flows to the electrode 7 which extends between the right and the lift of the bulb 1 as viewed from the electrode 6, then passes through discharge paths 11 and 12, and again flows to the electrode

7. In addition, since a high frequency voltage is applied across the electrodes 6 and 7 with the insulator 8 clamped therebetween, the electrodes 6 and 7 are placed in the same state as a kind of capacitor coupling, whereby a high frequency current flows through the insulator 8 between the electrodes 6 and 7. Namely, a state like an equivalent circuit is presumed to exist between the electrodes 6 and 7.

[0011]

The discharge lamp which discharges in this manner can emit stable visible light because a section in which discharge is unstable is nearly invisible from the effective emission surface 9. In addition, it is possible to obtain far more stable discharge by adjusting the thickness, the material and the like of the insulator 8 shown in Fig. 4 and adjusting the dielectric constant and the resistance value between the electrodes 6 and 7, whereby it is possible to obtain discharge which is stable to such an extent that a striped pattern of discharge is completely invisible from any angle. In addition, even in the case where discharge cannot be stabilized with the dielectric constant and the resistance value of the insulator 8, a similar result can be obtained in the case where electrical circuit devices, for example, a capacitor 14 and a resistor 15 are set to arbitrary values and provided between the electrodes 6 and 7, i.e., on the output side of the power source 4 as shown in Fig. 3.

[0012]

In the lamp having this construction, an insulating structure for the entire lamp need not necessarily be formed by providing the electrode 7 on the side of ground voltage.

[0013]

Fig. 5 shows a luminance stability characteristic chart of the effective emission surface of a fluorescent lamp which is lit by the conventional discharge system shown in Fig. 1, and Fig. 6 shows a luminance stability characteristic chart of the effective emission surface of a fluorescent lamp which is lit by the present inventive discharge system shown in Fig. 3. From a comparison between the characteristic charts of Figs. 5 and 6, it can be seen that in the conventional discharge system, a light ripple in light measurement occurs by approximately ±6%, while in the present inventive discharge system, a light ripple in light measurement is nearly 0%. The same result was obtained in the discharge system of Fig. 3 in which the resistor 15 and the capacitor 14 are inserted.

[0014]

[Advantage of the Invention]

As described hereinabove, according to the invention, it is possible to emit extremely stable visible light and/or ultraviolet light, and it is possible to provide stable light in the case of document illumination used in information equipment and in backlight units for liquid crystal panels and

the like.

[Brief Description of the Drawings]

[Fig. 1] An explanatory view of a conventional fluorescent lamp and power source.

[Fig. 2] An explanatory view of an A-A cross section of the fluorescent lamp.

[Fig. 3] An explanatory view of a fluorescent lamp and a power source according to the invention.

[Fig. 4] An explanatory view of an A-A cross section of the fluorescent lamp according to the invention.

[Fig. 5] A luminance stability characteristic chart of the conventional fluorescent lamp and power source.

[Fig. 6] A luminance stability characteristic chart of the fluorescent lamp and the power source according to the invention.

[Description of Reference Numerals and Signs]

1 tubular bulb

2, 3 external electrode

4 high frequency power source

5 fluorescent material

6 first electrode

7 second electrode

8 insulator

9 effective emission surface

13 aperture

Fig. 5, Fig. 6

LUMINANCE (RELATIVE VALUE)

TIME